

Advanced Research

Program Mission

The Advanced Research Program works to create public benefits through two types of activities. The first is a set of crosscutting studies and assessment activities in environmental, technical and economic analyses, coal technology export and international program support. The public benefits from these activities because the improvement of programs and regulatory activities will help to maximize their benefits and lower their costs. The second is a set of crosscutting fundamental and applied research programs which include coal utilization science, materials and components, bioprocessing of coal, and university-based research. The public benefits from these activities because the long-term, high-risk activities target areas where industry is reluctant to invest. These research activities can produce public benefits such as increased energy efficiency, reduced pollution, or more reliable power supplies. For example, the university-based research programs include the University Coal Research program and the Historically Black Colleges and Universities and Other Minority Institutions (HBCU/OMI) program, address the full spectrum of fossil utilization research and development, technology transfer, outreach, and private sector partnerships.

In the crosscutting studies and assessments subprograms, the thrusts of international program support, environmental activities, coal technology export, and technical and economic analysis are to complement and enhance all Fossil Energy endeavors by providing both financial and technological leverage. International involvement is limited to those selected areas where it has been determined that the U.S. will benefit at least to the extent it contributes. Fossil Energy, through these activities, always attempts to encourage the leveraging of research and development funds while promoting U.S. industrial interests and to use them as opportunities to achieve responsible international consensus and opinion on technical business assessment and policy issues.

The crosscutting fundamental and applied research programs focus upon developing the technology base in the enabling science and technology areas that are critical to the successful development of both superclean, very high efficiency coal-based power systems and coal-based fuel systems with greatly reduced or no net emissions of CO₂. These systems are encompassed in the Vision 21 energyplex. Advanced Research seeks a greater understanding of the physical, chemical, biological and thermodynamic barriers to achieving economic, technologic, and environmental goals and identifies ways to overcome those barriers. The program is unique in that it is directed to specific underlying fundamental scientific and engineering problems closely connected to short-term, mid-term and long-range Fossil Energy objectives.

In order to achieve these goals, an Advanced Research focus area on Computational Energy Sciences was established at the National Energy Technology Laboratory (NETL). This focus area will conduct simulations and modeling activities to produce a "technology base" from which the energy plants of the future will be designed, built and operated.

The Coal Utilization Science subprogram focuses on research pertinent to all coal utilization systems, with specific attention paid to increasing our knowledge of the principal mechanisms that control coal

conversion processes. It will address issues affecting the utilization of coal, and its primary thrust is in support of the development of the Vision 21 concept. It will involve novel concepts for CO₂ capture and sequestration, such as mineral carbonation, and virtual simulations and modeling of components and subsystems. It will also include research on instrumentation and diagnostics to support the development of advanced controls and sensors. High performance Advanced Materials and equipment are essential to advanced coal technologies. Thus, the thrust of the Advanced Materials subprogram is to develop materials for advanced gas separation and particulate removal, as well as to develop solutions to materials performance barriers unique to very high temperature, highly corrosive coal combustion and gasification environments. Exploratory research and innovation to maximize the use of coal in environmentally preferable ways is typified by the bioprocessing of coal subprogram. The focus of the Biotechnology subprogram is to conduct biological research to produce clean fuels and to reduce greenhouse gas emissions (NO_x, SO_x, and CO₂) from existing and new powerplants. The University Coal Research and HBCU/OMI subprograms are both education and training programs that support competitively awarded research grants at U.S. colleges and universities to address Fossil Energy's highest priority research needs.

Program Strategic Performance Goal

Approximately three quarters of the Advanced Research Program funding supports Program Strategic Performance Goal (PSPG) ER-2. The remainder supports education along with scientific efforts not directly related to any of the current PSPGs. Because of this, the Advanced Research Program has developed a set of annual goals along with a Midterm Performance Goal, which is equivalent in scope to a PSPG, to help track performance. They are:

Performance Indicator

- Midterm Performance Goal: Sustain US preeminence in fossil fuel technology by supporting development of material, computational method, and control system knowledge needed to bridge gaps between science and advanced engineering. Allow development, by 2010, of enabling technologies that support the goals of Vision 21 power systems.

Annual Performance Targets and Results

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Note: Annual targets for Advanced Research were not proposed prior to FY2003	Prepare and evaluate novel sensors and new materials for high temperature, oxidative environments to improve control, increase efficiency and performance, and/or achieve lower emissions of CO ₂ and other pollutants.	Complete qualification testing of ferritic alloys for the ultra supercritical (greater than 1250°F temperature, greater than 4700 psia pressure) steam cycle, use of these alloys will reduce capital costs by 3%, cut emissions by 6% and maintain low cost of electricity.

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
	<p>Complete preparation and communication of consolidated Advanced Research program and program implementation plans that incorporate guidance from workshops with external stakeholders.</p> <p>Provide student and faculty training and education through selection of 8 students to participate in the undergraduate internship program for fossil energy and environmental science research and through 15 total awards under the University Coal Research and HBCU/OMI programs for research on critical needs for enabling Vision 21 power systems.</p>	<p>Complete tests of 8 sensors and components with potential to provide improved process control, higher operating efficiencies, and reduced costs, through better management of solids flow, solids composition, and system temperature, in advanced coal power systems potentially capable of achieving goals of the National Energy Policy.</p> <p>Provide student and faculty training and education through selection of 8 students to participate in the undergraduate internship program for fossil energy and environmental science research and through 15 total awards under the competitive University Coal Research and Historically Black Colleges and Universities/Other Minority Institution programs for research on critical needs to achieve the efficiency and environmental goals established under the National Energy Policy and the President's Clear Skies Initiative for coal technologies.</p>

Funding Profile

(dollars in thousands)

	FY 2002 Comp. Approp.	FY 2003 Request	FY 2004 Base	FY 2004 Request	FY 2004 Request vs. Base	
					\$ Change	% Change
Advanced Research						
Coal Utilization Science . . .	\$6,354	\$8,000	\$8,000	\$9,000	\$1,000	12.5%
Materials	6,821	9,000	9,000	12,000	3,000	33.3%
Technology Crosscut						
Coal Technology Export	800	800	800	1,000	200	25.0%
Bioprocessing of Coal .	1,350	1,350	1,350	1,500	150	11.1%
Environmental Activities	1,900	2,000	2,000	2,000	0	0.0%
Technical & Economic Analyses	750	1,000	1,000	1,000	0	0.0%
International Program Support	950	1,000	1,000	1,000	0	0.0%
Focus Area for Computational Energy Science	5,000	3,000	3,000	3,000	0	0.0%
Subtotal, Technology Crosscut Research	10,750	9,150	9,150	9,500	350	3.8%
University Coal Research . .	2,922	4,000	4,000	5,000	1,000	25.0%
HBCUs, Education and Training	974	1,500	1,500	2,000	500	33.3%
Total, Advanced Research	\$27,821	\$31,650	\$31,650	\$37,500	\$5,850	18.5%

Funding by Site

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	\$Change	%Change
Ames National Laboratory	\$230	\$230	\$280	\$50	21.7%
Argonne National Lab (East)	988	988	988	0	0.0%
Idaho Nat'l Engineering & Environmental Lab . . .	570	570	570	0	0.0%
Los Alamos National Lab	600	600	100	-500	-83.3%
National Energy Technology Laboratory	5,620	5,970	5,970	0	0.0%
Oak Ridge National Lab	4,290	4,435	5,720	1,285	29.0%
Pacific Northwest Lab	770	770	690	-80	-10.4%
Sandia National Laboratories	550	550	650	100	18.2%
All Other	14,433	17,767	22,812	5,045	28.4%
Total, Advanced Research	\$27,821	\$31,650	\$37,500	\$5,850	18.5%

Site Description

Ames National Laboratory

The Ames National Laboratory, located in Ames, Iowa, conducts research and development in the area of Advanced Research on virtual simulations and high temperature materials.

Argonne National Laboratory (East)

The Argonne National Laboratory (ANL), located in Argonne, Illinois, is a major multi-program laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract. Argonne research for the Fossil Energy Advanced Research program supports DOE strategies to develop non-destructive testing examination of materials and mineral sequestration kinetics.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL), located outside of Idaho Falls, Idaho, conducts research and development in the area of Advanced Research on materials development and bio-processing research.

Los Alamos National Laboratory

The Los Alamos National Laboratory (LANL), located in Los Alamos, New Mexico, conducts research and development in the area of Advanced Research to model mineral sequestration and develop hydrogen separation membranes.

National Energy Technology Laboratory

The National Energy Technology Laboratory (NETL), located in Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma, is a multi-purpose laboratory, owned and operated by the U.S. Department of Energy. NETL conducts and implements science and technology development programs for the Department in energy and energy-related environmental systems. NETL's key functions are to shape, fund, and manage extramural (external) RD&D projects, conduct on-site science and technology research, and support energy policy development and best business practices within the Department.

Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), located in Oak Ridge, Tennessee, conducts research and development in the area of Advanced Research to develop materials and perform bio-processing research.

Pacific Northwest Laboratory

The Pacific Northwest Laboratory (PNNL), located in Richland, Washington, conducts research and development in the area of Advanced Research to perform materials research and environmental analyses.

Sandia National Laboratories

The Sandia National Laboratory (SNL), located in Albuquerque, New Mexico, and Livermore, California, conducts research and development in the area of Advanced Research to develop hydrogen separation membranes and conduct fundamental combustion research.

All Other

The Department's Advanced Research program, within the Fossil Energy and Development program, funds research at major performers at non-DOE locations. An example of these performers include the Albany Research Center which conducts research on materials and mineralization sequestration processes.

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Coal Utilization Science	6,354	8,000	9,000
■ Coal Utilization Science (Core)	6,291	7,920	6,831

Conduct research to enable reduction or elimination of environmental impacts of coal use; focus on greenhouse gases that may affect global climate change. Sensors and Controls: Complete pilot-scale tests of select gasification and combustion sensors; complete feasibility tests of other sensor development projects selected under FY 2002 solicitations. Select fewer projects for award under FY 2003 solicitations. Issue solicitation for development techniques focusing on application of nanotechnology to control and optimize Vision 21 plant efficiencies and emission performance. Continue stochastic modeling and systems analysis of Vision 21 concepts. Complete Round 2 course grid simulations and computational workbench projects and continue projects selected under round III of broad-based agency Vision 21 solicitation to develop critical enabling technologies for advanced power and fuel systems and in support of Vision 21. Investigate basic combustion and gasification chemistry to discern rates and mechanisms that control emissions behavior of coal under advanced and conventional combustion gasification conditions to efficiently minimize NO_x, SO_x, air toxics, and other pollutants in support of the Clear Skies Initiative. Develop predictive models as a tool for designers of Vision 21 plants. Demonstrate the feasibility of the in-situ CO₂ mineral sequestration concept through laboratory tests of drill-core samples and maintain minimum levels of fundamental lab-scale research to addresses process

design issues. *Participants include: NETL, SNL, CMU, U. of Pittsburgh, Princeton, ARC.*

FY 2003 and FY 2002 funding continued development of instrumentation, diagnostics and controls for advanced power systems; model testing and research for Virtual Demonstration plant; development of critical enabling technologies in support of Vision 21; fundamental coal combustion research; and research on fundamental mechanisms for CO₂ mineral sequestration process. *Participants included: Ames Research Lab, SNL, ARC, LANL.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ Mercury Control	0	0	2,079
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Conduct fundamental research on mercury formation and control. As part of anew sensors and control solicitation, develop sensors to detect and monitor mercury emissions. Develop atmospheric modeling (plume chemistry and deposition) with a focus towards mercury. *Participants to be determined.*

No funding was requested for this activity in FY 2003 and FY 2002..

■ Program Support	63	80	90
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Fund technical and program management support.

Materials	6,821	9,000	12,000
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■ High Temperature Materials Research	4,870	5,015	4,740
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Develop improved materials for high-temperature, high-pressure heat exchangers, high-temperature inorganic membranes, and activated carbons for next generation, ultra clean fossil energy power systems. Develop new alloys to include intermetallics, advanced austenitic alloys, advanced ferritic alloys, and oxide-dispersion-strengthened alloys. Functional materials research addresses hot-gas particulate filters, gas separation membranes, and physical absorbents, i.e, advanced carbons and non-destructive evaluation techniques. *Participants include: ANL, INEEL, ORNL, Ames, Huntington Alloys, NETL.*

FY 2003 and FY 2002 funding continued development of the high temperature structural and functional materials that are critical enabling technologies needed to achieve the highly efficient, economical and environmentally clean fossil energy power systems for Vision 21. *Participants included: ANL, INEEL, ORNL, Eltron, Ames, Huntington Alloys, NETL.*

■ Materials for Ultra Supercritical and Gas Separation Systems	1,881	3,895	4,640
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Develop alloys for ultra supercritical systems with operating temperatures raised to 1400-1600°F; ensure the weldability of these high temperature materials, and develop the base materials technology needed to develop steam turbines capable of operating at the ultra supercritical temperature and pressure conditions which are critical to the success of not only the ultra

supercritical program, but also the Vision 21 program. Pursue breakthrough concepts to develop materials for achieving very low cost hydrogen and oxygen separation from mixed gas streams and for stabilizing greenhouse gases for Vision 21 energy plants. *Participants include: LANL, SNL, ORNL, PNNL, ARC, Energy Industries of Ohio.*

FY 2003 and FY 2002 funding supported development of alloys for ultra supercritical systems and new materials able to separate hydrogen and oxygen and for stabilizing greenhouse gases at very low costs. These are critical enabling technologies needed to make deployment of Vision 21 energy plants possible. *Participants included: LANL, SNL, ORNL, PNNL, ARC, Energy Industries of Ohio.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Materials for Mercury Control** 0 0 500

Evaluate novel materials for the conversion or removal of mercury from process streams.
Participants to be determined.

No funding was requested for this activity in FY 2003 and FY 2002..

■ **Materials for Advanced Fuel Cell Concepts** 0 0 2,000

Develop advanced concepts that utilize carbon material from coal directly in a fuel cell. Such a concept will permit high and intermediate temperature fuel cells to directly convert carbon to electrical power without the need of an intermediate coal gasification step. National Laboratories may also contribute materials research in support of other advanced fuel cell concepts.
Participants to be determined.

No funding was requested for this activity in FY 2003 and FY 2002..

■ **Program Support** 70 90 120

Fund technical and program management support.

Technology Crosscut	10,750	9,150	9,500
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Coal Technology Export 800 800 1,000

■ **Coal Technology Export** 800 800 1,000

Sustain continued support for collaboration of zero emission technologies internationally. Intensify the pursuit of opportunities identified by the World Energy Council Committee on Cleaner Fossil Fuel Systems and the Southern States Energy Board for the international sale and deployment of U.S. clean coal technologies and advanced power systems. Continue pursuit of the establishment of effective partnerships to advance U.S. interests in environmental protection by promoting deployment of cleaner energy systems through training, conferences, site visits and information and technical exchanges on clean power systems, best practices, privatization with

targeted utilities and governments and advising countries on identification and elimination of barriers for deployment of cleaner coal and power systems. This funding level will support fewer conferences and site visits. *Participants to be determined.*

FY 2003 and FY 2002 funding continued development of training, conferences, site visits, and information and technical exchanges in order to promote the deployment of cleaner energy. *Participants included: Latin America, China, Australia, Africa, India.*

(dollars in thousands)			
	FY 2002	FY 2003	FY 2004
Biotechnology of Coal	1,350	1,350	1,500
■ Biotechnology of Coal	1,336	1,336	1,485

Initiate large scale testing to develop toxin to safety control zebra mussels as a means of improving the efficiency and reliability of existing power plants. Initiate development of technical protocol for screening marine microalgae for maximum biofixation and its conversion into alternative fuels. Develop biological processes for fuels that have a significantly lower unit content of greenhouse gas than currently available fuel to reduce the impact on global climate change. Investigate global, natural CO₂ mitigation strategies such as whittings and ocean scale algae sequestration. Continue development of biogeochemical environmental remediation of ammonia discharges associated with coal wastes from existing power plants. In furtherance of launching the hydrogen economy, investigate biohydrogen generation from carbon containing waste products to determine food sources that will support microbial growth and hydrogen production, conduct tests at bench scale. Investigate novel bio-environmental remediation processes related to coal conversion technology. *Participants include: ORNL, INEEL, U. State of NY, Cal. State U.*

FY 2003 and FY 2002 funding continued development of CO₂ mitigation strategies, such as whittings; develop toxin for control of zebra mussels; and biohydrogen generation from carbon containing waste products. *Participants included: ORNL, INEEL, U. of State of NY, Calif. State U.*

■ Program Support	14	14	15
Fund technical and program management support.			
Environmental Activities	1,900	2,000	2,000
■ Environmental Analyses and Studies	1,710	1,800	1,800

Continue, at a reduced level, analyses of issues associated with air and water quality, solid waste disposal, and toxic substances, and global climate change. Continue emission trends and forecast studies. *Participants include: ANL, ICF, Resource Dynamics, TMS, PNNL.*

FY 2003 and FY 2002 funding continued environmental issues analyses of ambient, water, solid effluents, and global climate change and conducted emission trends and forecast studies. *Participants included: ANL, ICF, Resource Dynamics, TMS, PNNL.*

(dollars in thousands)

FY 2002	FY 2003	FY 2004
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■ **Environmental Related Support to Field Offices** 190 200 200

Provide environmental, safety and health, safeguards and security and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. *Participants include: TMS.*

FY 2003 and FY 2002 funding continued support to provide environmental, safety and health, safeguards and security, and National Environmental Policy Act (NEPA) assistance and assessment support to field offices. *Participants included: TMS.*

Technical and Economic Analyses 750 1,000 1,000

■ **Technical and Economic Analyses** 750 1,000 1,000

Continue studies supporting multi-year planning FE strategy and program formulation; conduct contract fewer studies on issues that crosscut FE programs including strategic benefits of and new markets for fossil fuel technology. Conduct critical studies to identify major challenges, "leapfrog" technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. *Participants include: ANL, ICF, EIA, Resource Dynamics, TMS.*

FY 2003 and FY 2002 funding continued studies supporting multi-year planning, FE strategy and program formulation; conducted contract studies on issues that crosscut FE programs including strategic benefits of and new markets for fossil fuel technology. Conducted critical studies to identify major challenges, "leapfrog" technologies, and advanced concepts that are applicable to fossil energy systems, and have the potential to improve their efficiency, cost, and/or environmental performance. *Participants included: ANL, ICF, EIA, Resource Dynamics, TMS.*

International Program Support 950 1,000 1,000

■ **International Program Support** 950 1,000 1,000

Continue support of Fossil Energy's commitment to the International Energy Agency (IEA) program effort. Provide leadership, direction, cooperation and coordination of office activities with other Federal agencies, state and local governments, energy trade associations, and the energy industry. Preserve and enhance active relationships with national and international organizations such as the World Energy Council (WEC), United States Energy Association (USEA), Southern States Energy Board (SSEB) and universities and other non-governmental organizations. Focus on expanding cleaner energy technology power systems activities in Southern and Western regional African countries, Eastern Europe, the Pacific Rim, Russia and Newly Independent States, South Asia/Near East, Western Europe, and the Western Hemisphere. Determine opportunities for cleaner power systems and clean fuels from coal in targeted countries. *Participants to be determined.*

FY 2003 and FY 2002 funding continued the maintenance and heightening of established relationships with national and international organizations with emphasis on collaboration,

transfer, and deployment of zero emission technologies. *Participants included: WEC, USEA, SSEB, universities and other non-governmental organizations.*

(dollars in thousands)			
	FY 2002	FY 2003	FY 2004
Focus Area for Computational Energy Science	5,000	3,000	3,000
■ Focus Area for Computational Energy Science . . .	4,950	2,970	2,970
<p>NETL is to continue the development of virtual demonstration capability using mathematical simulations and modeling to improve the speed and reduce the costs of technology systems that have high efficiencies with near-zero emissions to reduce the effects on global warming. Develop simulations that couple fluid flow, chemical reactions, heat generation, heat transfer, and electrochemistry for modeling multi-dimensional transients in fuel cells, heat engines, gasifiers, and other crucial unit processes in Vision 21 plants. Complete CFD models of fuel cells, turbines, and gasifiers. Enhance multi-phase flow models (MFIx) with meshing, large eddy simulations and chemistry and heat transfer improvements. Integrate subsystem component modules and dynamic system models to simulate a first case Vision 21 plant. Continue to perform data reduction and data extraction on extensive information available from simulations of advanced energy plants for incorporation into codes being developed. Eliminate supercomputing science consortium supporting activity. <i>Participants include: NETL.</i></p> <p>FY 2003 and FY 2002 funding continued development of models and dynamic simulations of advanced energy plants, including modeling tools for sub-elements in turbines and fuel cells. Integration of subsystem component modules and dynamic system models into virtual models. Supercomputing Science Consortium support in advanced simulations utilizing high performance computing and communications. <i>Participants included: NETL, CMU, U. of WVa., State of WVa., PSCC, U. of Pittsburgh.</i></p>			
■ Program Support	50	30	30
Fund technical and program management support.			
University Coal Research	2,922	4,000	5,000
■ University Coal Research	2,892	3,960	4,950

Support grants at U.S. universities which emphasize longer-term research that will accelerate technology development and identify breakthrough technologies for the next century; focus on scientific and technological issues that are key to achieving FE’s strategic objectives; continue to support critical key research areas to include Vision 21, global climate change, materials, sensors and controls, and by-products from coal. Breakthrough technologies for the measurement, characterization, and the development of cost-effective control technologies for fossil coal-based mercury emissions will also be sought. Continue collaboration through joint proposals involving university and industry teams, and teams with three or more universities. Continue to explore novel approaches and innovative concepts developed in other scientific and technological areas

that will assist in developing breakthrough technologies for coal utilization. Decrease follow-on support to previous grantees of the Innovative Concepts Phase Two Program. Continue support to the undergraduate internship program to allow students having science and engineering majors to perform fundamental research in the areas of environmental science and fossil energy, where graduate level courses or relevant degrees are not offered in these areas at their institutions. Extend the supporting of grants to include studies of regulatory and legal impacts on fossil energy technologies. *Participants to be determined.*

FY 2003 and FY 2002 funding provided competitively awarded research grants to U.S. colleges and universities to address Fossil Energy's highest priority research needs, supported joint proposals involving university and industry teams of researchers, and continued to explore novel approaches and innovative solutions to achieve technological breakthroughs for clean coal utilization and support to Vision 21. *Participants included: Various colleges and universities.*

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
■ Program Support	30	40	50
Fund technical and program management support.			
HBCUs, Education and Training	974	1,500	2,000
■ HBCUs, Education and Training	964	1,485	1,980
Conduct research activities with HBCU and other minority institutions and support an HBCU annual technology transfer symposium. <i>Participants to be determined.</i>			
FY 2003 and FY 2002 funding continued research activities at HBCU and other minority institutions and supported HBCU annual technology transfer symposium. <i>Participants included: Various colleges and universities.</i>			
■ Program Support	10	15	20
Fund technical and program management support.			
Total, Advanced Research	27,821	31,650	37,500

Explanation of Funding Changes

FY 2004 vs. FY 2003 (\$000)

Coal Utilization

- | | |
|---|-------|
| <ul style="list-style-type: none"> ■ Increase in Coal Utilization due to fundamental mercury research, development of mercury and nanotechnology sensors, and atmospheric modeling | 1,000 |
|---|-------|

Materials

- | | |
|---|-------|
| <ul style="list-style-type: none"> ■ Increase in Materials research in ultra supercritical materials, mercury control, and support to Coal and Power fuel cell program | 3,000 |
|---|-------|

Technology Crosscut

Coal Technology Export

- | | |
|---|-----|
| <ul style="list-style-type: none"> ■ Increase in Coal Technology Export due to additional international commitments to enhance markets for U.S. coal | 200 |
|---|-----|

Bioprocessing of Coal

- | | |
|---|-----|
| <ul style="list-style-type: none"> ■ Increase in Bioprocessing of Coal due to investigation of novel bioprocessing systems | 150 |
|---|-----|

University Coal Research

- | | |
|---|-------|
| <ul style="list-style-type: none"> ■ Increase in University Coal Research will provide for provide support to develop mercury control technologies | 1,000 |
|---|-------|

HBCUs, Education and Training

- | | |
|---|-----|
| <ul style="list-style-type: none"> ■ Increase in HBCUs, Education and Training will provide for increased activities at HBCU's and other minority institutions | 500 |
|---|-----|

Total Funding Change	5,850
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